

WHAT IS CLAIMED IS:

1. A multilayer semiconductor laser, comprising:
a substrate;
a multilayer semiconductor heterostructure formed on the substrate;
5 said heterostructure being divided into a plurality of electrically pumped regions and an elongated optically pumped region;
said optically pumped region being optically pumped by radiation having a first wavelength generated and deposited laterally into the optically pumped region by said electrically pumped regions; and
10 wherein said optically pumped region is configured to generate radiation having a second wavelength longer than said first wavelength in response to said optical pumping and said second wavelength radiation is delivered as output radiation from one end of said optically pumped region.
- 15 2. The laser of claim 1, wherein each of said electrically pumped regions has, at an end thereof furthest from said optically pumped region, a multilayer mirror having a high reflectivity at said first wavelength and a low reflectivity at said second wavelength.
- 20 3. The laser of claim 2, wherein said reflectivity at said first wavelength is greater than 99% and said reflectivity at said second wavelength is less than 5%.
- 25 4. The laser of claim 1, wherein said plurality of electrically pumped regions includes a first plurality thereof arranged along one side of said optically pumped region and a second plurality thereof arranged along an opposite side of said optically pumped region.
5. The laser of claim 4, wherein each of said electrically pumped regions is laterally separated from an adjacent one thereof by a first groove formed in said heterostructure.

6. The laser of claim 5, wherein each of said electrically pumped regions is longitudinally separated from said optically pumped region by a second groove formed in said heterostructure.

5 7. The laser of claim 1, wherein said heterostructure includes a quantum-well layer sandwiched between upper and lower waveguide layers, said quantum-well layer and waveguide layers being sandwiched between upper and lower cladding layers.

8. The laser of claim 7, wherein each of said electrically pumped layers includes
10 an electrode layer surmounting said upper cladding layer.

9. A multilayer semiconductor laser, comprising:
a substrate;
a multilayer semiconductor heterostructure formed on the substrate;
15 said heterostructure being divided into a plurality of electrically pumped regions and an elongated optically pumped region;
said optically pumped region being optically pumped by radiation having a first wavelength generated and deposited laterally into the optical pumped region by said electrically pumped regions;
20 wherein said optically pumped region is configured to generate radiation having a second wavelength longer than said first wavelength in response to said optical pumping and said second wavelength radiation is delivered as output radiation from one end of said optically pumped region; and
wherein each of said electrically pumped regions has, at an end thereof
25 furthest from said optically pumped region, a first multilayer mirror having a high reflectivity at said first wavelength and a low reflectivity at said second wavelength.

10. The laser of claim 9, wherein said plurality of electrically pumped regions includes a first plurality thereof arranged along one side of said optically pumped region and
30 a second plurality thereof arranged along an opposite side of said optically pumped region.

11. The laser of claim 10, wherein said electrically pumped regions are laterally separated from each other by a plurality of first grooves, with one of said first grooves between adjacent ones of said electrically pumped regions.

5 12. The laser of claim 11, wherein said electrically pumped regions are longitudinally separated from said optically pumped region by two second grooves formed in said heterostructure, with one of said second grooves formed along one edge of said optically pumped region and the other of said second grooves formed along an opposite edge of said optically pumped region.

10 13. The laser of claim 12, wherein each of said electrically pumped regions has a laser resonator formed between said mirror on one end thereof and one of said second grooves.

15 14. The laser of claim 11, wherein an end of each of said electrically pumped regions opposite said mirrored end thereof are continuous with said optically pumped region, wherein each of said electrically pumped regions has the same width, wherein there are same number of said electrically pumped regions on each side of said optically pumped region and said electrically pumped regions on opposite sides of said regions are aligned with each other, and wherein for each pair of aligned electrically pumped regions a laser resonator is formed between said mirror on the end of one of said electrically pumped regions and said mirror on the end of the other of said electrically pumped regions.

25 15. A multilayer semiconductor laser, comprising:

a substrate;

a multilayer semiconductor heterostructure formed on the substrate;

said heterostructure being divided into an elongated first region having arranged along each side thereof a plurality of electrically pumped second regions; and

30 said electrically pumped regions having equal width and having equal lateral spacing, with each of said electrically pumped regions on one side of said first region

being aligned with a corresponding one of said electrically pumped regions on the opposite side of said first region, each of said electrically pumped regions having, at an end thereof furthest from said first region, a multilayer mirror having a high reflectivity at said first wavelength and a low reflectivity at a second wavelength longer than said first wavelength, said aligned ones of said electrically pumped regions generating laser radiation having a first wavelength, said first wavelength radiation circulating laterally through said first region between said first mirrors on the ends of said aligned ones of said electrically pumped regions with a portion of said circulating first wavelength radiation being absorbed in said first region in passing therethrough;

said first region being optically pumped by said absorbed first-wavelength radiation and said first region having at one end thereof a second multilayer mirror having a high reflectivity at said second wavelength and at an opposite end thereof a third mirror having a lower reflectivity at said second wavelength than said first mirror, whereby said optically pumped first region generates radiation having said second wavelength in response to said optical pumping, and said second wavelength radiation circulates in said optically pumped region between said second and third mirrors and is delivered as output radiation via said third mirror.

16. The laser of claim 15, wherein said heterostructure includes a quantum-well layer sandwiched between upper and lower waveguide layers, said quantum-well layer and waveguide layers being sandwiched between upper and lower cladding layers.

17. The laser of claim 16, wherein each of said electrically pumped regions includes an electrode layer surmounting said upper cladding layer.

18. The laser of claim 17, wherein adjacent ones of said electrically pumped second regions are laterally separated by a groove etched in said heterostructure.

19. The laser of claim 18, wherein said groove has a width of about 10.0 micrometers.

20. The laser of claim 18, wherein said groove extends in depth at least to said quantum-well layer.

21. The laser of claim 18, wherein said groove extends in depth through said lower waveguide layer.

22. A multilayer semiconductor laser, comprising:

a substrate;

a multilayer semiconductor heterostructure formed on the substrate;

said heterostructure being divided into an elongated first region having arranged along each side thereof a plurality of electrically pumped second regions;

adjacent ones of said electrically pumped regions being laterally spaced apart and from each other by a first groove, and each of said electrically pumped regions longitudinally spaced from said first region by one of two first grooves formed in said heterostructure, one thereof along each side of said first region, each of said electrically pumped regions having, at an end thereof furthest from said first region, a multilayer mirror having a high reflectivity at said first wavelength and a low reflectivity at a second wavelength longer than said first wavelength, each of said electrically pumped regions generating laser radiation having a first wavelength and delivering said first wavelength radiation across said groove laterally into said first region; and

said first region being optically pumped by said first-wavelength radiation delivered thereto, and said first region having at one end thereof a second multilayer mirror having a high reflectivity at said second wavelength and at an opposite end thereof a third mirror having a lower reflectivity at said second wavelength than said first mirror, whereby said optically pumped first region generates radiation having said second wavelength in response to said optical pumping, and said second wavelength radiation circulates in said optically pumped region between said second and third mirrors and is delivered as output radiation via said third mirror.

23. The laser of claim 22, wherein said heterostructure includes a quantum-well layer sandwiched between upper and lower waveguide layers, said quantum-well layer and waveguide layers being sandwiched between upper and lower cladding layers.

5 24. The laser of claim 23, wherein each of said electrically pumped regions includes an electrode layer surmounting said upper cladding layer.

25. The laser of claim 18, wherein said first and second grooves have a width of about 10.0 micrometers.

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26. The laser of claim 18, wherein said first groove depth extends at least to said lower cladding layer and said second groove depth extends at least to said quantum-well layer.

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27. A multilayer semiconductor laser, comprising:
a substrate;
a multilayer semiconductor heterostructure formed on the substrate;
said heterostructure being divided into an elongated first region and a plurality of electrically pumped second regions;
said first region being optically pumped by radiation having a first wavelength generated and deposited laterally into said optically pumped region by said electrically pumped regions; and

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wherein said optically pumped first region is in a laser resonator and generates radiation having a second wavelength longer than said first wavelength in response to said optical pumping, said second wavelength radiation being delivered as output radiation from one end of said optically pumped region.

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28. The laser of claim 27, wherein said heterostructure includes a quantum-well layer sandwiched between upper and lower waveguide layers, said quantum-well layer and waveguide layers being sandwiched between upper and lower cladding layers.

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29. The laser of claim 28, wherein said quantum well layer has a gain bandwidth characteristic of the material from which it is formed and said first and second wavelengths are within said gain bandwidth.

5 30. The laser of claim 29, wherein said quantum-well layer material is InGaAs, said first wavelength is about 965 nanometers and said second wavelength is about 980 nanometers.

10 31. A method of making a semiconductor laser comprising the steps of:
 depositing a multilayer heterostructure on a substrate;
 etching the surface of the heterostructure to define a first region adjacent to a plurality of second regions, said second regions capable of being electrically pumped in order to generate optical radiation for pumping said first region to cause said first region to generate laser radiation;
15 coating at least one end of said first region to provide high reflectivity at the wavelength of the laser radiation; and
 coating at least one end of each of said second regions to provide high reflectivity at the wavelength of said pump radiation.

20 32. The method of claim 31, wherein said etching step is performed by etching a plurality of linear grooves in the heterostructure to define an elongated first region with the second regions being positioned to laterally deposit the optical pump radiation in the first region.